Roll No.											

PRESIDENCY UNIVERSITY

BENGALURU

School of Engineering

Mid - Term Examinations - November 2024

Semester: V	**Date**: 08/11/2024 (Friday)
Course Code: PET3011	**Time**: 02:00pm – 03:30pm
Course Name: Well Intervention Technologies	**Max Marks**: 50
Program: B.Tech. (Petroleum Engineering)	**Weightage**: 25%

Instructions:

(i) Read all questions carefully and answer accordingly.

(ii) Do not write anything on the question paper other than roll number.

Part A

Answer ALL the Questions. Each question carries 2 marks. **5Q x2M=10M**

1	Distinguished between "Simulation" and "Stimulation".	2 Marks	L1	CO1
2	State two features of "Flanged Type Xmas tree" and "Mono-block" type Xmas tree".	2 Marks	L1	CO1
3	Name various Workover Rigs.	2 Marks	L1	CO1
4	State the role of "Injector" and "Gooseneck" in Coil tubing.	2 Marks	L1	CO2
5	Define "Mud Acid". Mention two major advantages Acetic acid in terms of Matrix acidization.	2 Marks	L1	CO2

Part B

Answer ALL Questions. Each question carries 10 marks. **4QX10M=40M**

6	Given the distinct advantages of open hole, cased hole, and liner completions—with open hole completions offering better reservoir contact, cased hole completions providing greater well control and flexibility, and liner completions offering a hybrid solution for selective zonal isolation—Discuss your priorities while selecting the completion type in a well with both highly productive zones and weak, water-prone formations, where long-term production optimization, minimal formation damage, and future intervention flexibility are key concerns. Can you justify the trade-offs involved in selecting one method over the others in terms of operational complexity, cost, and long-term well integrity?	10 Marks	L2	CO1

or

7 You are tasked with completing an oil well that has been drilled to a depth of 12,000 feet, encountering multiple hydrocarbon-bearing zones. The well requires protection against sand production, needs flow control to manage production from different zones, and has a highly sensitive formation that could be damaged by traditional completion fluids. 10 Marks L2 CO1

Question:

Given the following well completion requirements, how would you utilize casing and tubing, a wellhead, packers, a perforating gun, and flow control devices to ensure safe and efficient production from the well? Additionally, what sand control techniques would you implement to prevent sand from entering the wellbore, and what completion fluids would you choose to protect the sensitive formation?

Points to Consider:

a. Casing and Tubing: How would you design the casing and tubing to isolate different formation layers and transport produced fluids to the surface?

b. Wellhead: Explain the role of the wellhead components (casing head, tubing head, and Christmas tree) in controlling well pressure and hydrocarbon flow.

c. Packers: Where and why would you place mechanical or hydraulic packers to prevent fluid movement between zones?

d. Perforating Gun: How would you utilize a perforating gun to optimize flow from the hydrocarbon-bearing zones?

e. Flow Control Devices: Describe the use of sliding sleeves, safety valves, and gas lift valves to manage production, enhance safety, and facilitate artificial lift.

f. Sand Control Tools: Which sand control method (gravel packs or sand screens) would you choose, and why?

g. Completion Fluids: What type of completion fluid would you select to manage wellbore pressure while protecting the sensitive formation?

Outcome Expected:

Your solution should detail a step-by-step approach that ensures zone isolation, production optimization, sand prevention, and protection of sensitive formations during the completion process.

8 Analyze the variations in gun size, explosive charge size, wellbore fluid pressure, temperature, and density, alongside gun clearance, formation rock compressive strength, and the radial support of the casing and cement sheath, influence the performance of a shaped charge and the strategies engineers can employ to optimize charge effectiveness while minimizing operational risks and formation damage. 10 Marks L2 CO1

or

9 Summarize the use of a conical liner in a shaped charge influences the physical performance characteristics of the perforation, including jet formation and penetration depth, and analyze how factors such as liner material, charge design, and well conditions affect the properties and extent of the crushed zone, ultimately impacting overall well productivity and efficiency. 10 Marks L2 CO1

10 A limestone formation with a porosity of 0.18 contains 20 v% of mineral PQR_5S_3 (composition: $P_4QR_5S_3$) and is to be acidized using a HF/HCl mixture solution. A preflush of 18 wt% HCl solution will be injected ahead of the mixture to dissolve the PQR_5S_3 mineral and create a low pH environment. The chemical reaction for the dissolution of PQR_5S_3 with HCl is as follows: 10 Marks L3 CO2

$P_4QR_5S_3 + HCl \rightarrow PCl_3 + QR_2 + HS + SCl_2$ (stoichiometric balance not done)

If the atomic weights of P, Q, R, and S are 45 g/mol, 95 g/mol, 50 g/mol, and 35 g/mol respectively, and the objective is to remove all PQR_5S_3 minerals in a region extending 1 ft beyond a 0.5-ft radius wellbore before the HF/HCl stage enters the formation, solve for the minimum preflush volume required in terms of gallon per foot of pay zone? Consider Specific gravity of acid is 1.07 and Density of mineral is 210 pcf. Express the answer in terms of gal wt% HCl solution/ft pay zone.

Or

11 A 120-ft thick, 85-md sandstone reservoir at a depth of 13,500 ft is to be acidized using a mixture of 12% HCl and a mutual solvent. The acid mixture has a specific gravity of 1.12 and a viscosity of 1.9 cp at the reservoir temperature of 275°F, and is to be injected down a 3.0-in. inside diameter (ID) coil tubing. The formation fracture gradient is 0.9 psi/ft, and the wellbore radius is 0.35 ft. The reservoir pressure is 3,800 psia, and the drainage area radius is 1,100 ft with a skin factor of 22. The horizontal section of the well extends for 600 ft and has a 5.5-in. casing. 10 Marks L3 CO2

(a) Assuming a friction pressure drop of 18 psi per 100 ft of coil tubing in the vertical section, and an additional 12% frictional loss in the horizontal section, compute the maximum allowable acid injection rate if the safety margin is set at 500 psi.

$$q_{i,\max} = \frac{4.917 \times 10^{-6} kh(p_{bd} - \bar{p} - \Delta p_{sf})}{\mu_a \left(\ln \frac{0.472 r_e}{r_w} + S \right)},$$

where

q_i = maximum injection rate, bbl/min
k = permeability of undamaged formation, md
h = thickness of pay zone to be treated, ft
p_{bd} = formation breakdown pressure, psia
$\bar{p}$ = reservoir pressure, psia
Δp_{sf} = safety margin, 200 to 500 psi
μ_a = viscosity of acid solution, cp
r_e = drainage radius, ft
r_w = wellbore radius, ft
S = skin factor, ft.

(b) Determine the maximum expected surface injection pressure at this maximum injection rate, considering both the pressure drop due to friction in the tubing and the additional pressure losses in the horizontal section of the well.

12	A 30 wt% HCl solution is to be injected to propagate wormholes 4 ft from a 0.4-ft radius wellbore in a calcareous sandstone formation with a specific gravity of 2.65 and a porosity of 0.18. The designed injection rate is 0.15 bbl/min-ft, and the diffusion coefficient is assumed to be 1.2×10^{-9} m^2/sec. The density of the 30% HCl is 1.2 g/cc. For wormhole breakthrough, consider that 1.2 pore volumes are required for effective acid penetration. Compute the acid volume requirement using: (a) Daccord's model. (b) The volumetric model. Consider Fractal Dimension as 1.6 and b= 105×10^{-5}	10 Marks	L2	CO2

$$V_h = \frac{\pi \phi D^{2/3} q_h^{1/3} r_{wh}^{d_f}}{b N_{Ac}}$$

where

V_h = required acid volume per unit thickness of formation, m^3/m
ϕ = porosity, fraction
D = molecular diffusion coefficient, m^2/s
q_h = injection rate per unit thickness of formation, m^3/sec-m
r_{wh} = desired radius of wormhole penetration, m
d_f = 1.6, fractal dimension
b = 105×10^{-5} in SI units
N_{Ac} = acid capillary number, dimensionless,

or

13	An oil company implements matrix stimulation with acid-based fluids on an aging well to enhance production. However, instead of improvement, the well's performance declines. The engineers analyze potential causes, such as structural damage from the acid, migration of trapped particles clogging pores, chemical reactions creating blockages, unexpected interactions with crude oil, or changes in rock-fluid interactions. Discuss the factors led to the decline in well performance after the treatment. Identify potential issues that could arise during matrix stimulation and explain how they might affect the well's productivity	10 Marks	L2	CO2